MASSACHUSETTS

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Program Description

Biological monitoring techniques are an important component of the watershed-based surface water quality monitoring and assessment program administered by the Massachusetts Department of Environmental Protection (MADEP). The goals of this program are to assess whether the surface waters of Massachusetts are of sufficient quality and quantity to support their multiple uses, and to report those findings in watershed assessment reports, the 305(b) Summary of Water Quality Report and the 303(d) List of Impaired Waters. Monitoring is also used to identify causes and sources of water use impairments as the first step toward developing water quality and quantity management strategies.

MADEP biologists assess the condition of resident macroinvertebrate, fish and algal communities in streams to provide a direct measure of the ecological response to the cumulative effects of pollutant loadings and habitat degradation. These bioassessments, coupled with water quality data and other relevant information, form the basis for determining the aquatic life use-support status, as defined in the *Massachusetts Surface Water Quality Standards*.

Rapid bioassessment protocols (RBPs), based on those developed by the USEPA, are used to monitor the integrity of the benthic macroinvertebrate community. A targeted sampling design is employed whereby sites are selected for upstream/downstream comparisons, comparisons against a regional or surrogate reference, or for long-term trend monitoring. Based on scoring of several metrics, four categories of impairment are discerned by the RBP analysis (non-impaired, slightly impaired, moderately impaired, and severely impaired). Approximately 50-75 sites are assessed each year in accordance with a rotating watershed monitoring scheme.

The analysis of the structure of the finfish community as a measure of biological integrity is another component of the water quality monitoring program. MADEP utilizes a standardized method based on RBP V (USEPA 1989) to improve data comparability among wadeable sampling sites. The fish collection procedures involve sampling habitats in relative proportion to their local availability. A representative 100-meter stream reach is selected to include the primary physical habitat characteristics of the stream (i.e., riffle, run, and pool habitats). Electrofishing is the preferred method for obtaining a representative sample of the fish community at each sampling site. Fish (except young-of-the-year) collected within the study reach are identified to species, counted, and examined for external anomalies, (i.e., deformities, eroded fins, lesions, and tumors). Aquatic life use-support status is derived from a knowledge of the environmental requirements (e.g., water temperature and clarity, dissolved oxygen content) and relative tolerance to water pollution of the species collected.

Algae represent a third community that may be assessed. The analysis of the attached algae or periphyton community in shallow streams, or the phytoplankton in deeper rivers and lakes employs an indicator species approach whereby inferences on water quality conditions are drawn from an understanding of the environmental preferences and tolerances of the species present. Because the algal community typically exhibits dramatic temporal shifts in species composition throughout a single growing season, results from a single sampling event are generally not indicative of historical conditions. For this reason the information gained from the algal community assessment is more useful as a supplement to the assessments of other communities that serve to integrate conditions over a longer time period.

In addition to the community analyses described above, MADEP also collects some fish to be assayed for the presence of toxic contaminants in their tissues. The goal of this monitoring element is primarily to provide data for the assessment of the risk to human consumers associated with the consumption of freshwater finfish. In the past fish collection efforts were generally restricted to waterbodies where wastewater discharge data or previous water quality studies indicated potential toxic contamination problems. More recently, concerns about mercury contamination from both local and far-field sources have led to a broader survey of waterbodies throughout Massachusetts. In both cases, nonetheless, the analyses have been restricted to edible fish fillets.

Documentation and Further Information

Commonwealth of Massachusetts Summary of Water Quality 2000

Massachusetts Surface Water Quality Standards, May 1997: http://www.state.ma.us/dep/bwp/iww/files/314004.pdf

For a list of online resources, go to: http://www.state.ma.us/dep/brp/wm/wmpubs.htm#other

Jessup, B.K., J. Gerritsen, M.T. Barbour, and R. Haynes. 2001. *Analysis and Interpretation of Pilot Study Data as an Initial Step in the Development of Biological Criteria for Streams and Small Rivers in Massachusetts*. Prepared by Tetra Tech, Inc., for Massachusetts Department of Environmental Protection, Worcester, MA.

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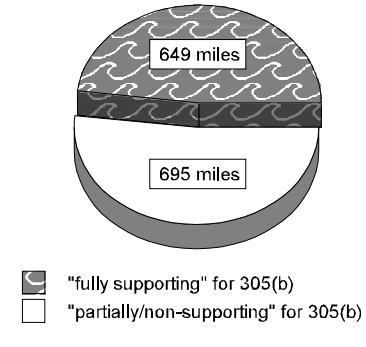
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations, ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
		TMDL assessment and monitoring
	✓	other: development of numeric biocriteria
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using a state based program)*	**8,229**
Total perennial miles	7,133
Total miles assessed for biology	**1,344**
fully supporting for 305(b)	649
partially/non-supporting for 305(b)	695
listed for 303(d)	695
number of sites sampled *(on an annual basis)**	~100
number of miles assessed per site*	site specific

1,344 Miles Assessed for Biology



*The number of sites sampled varies annually, as does the number of miles assessed per site.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm water vs. Cold water	
ALU designations in state water quality standards	Three designations: 1. General Aquatic Life Support 2. Cold Water/Warm Water Fishery 3. Shellfish Harvesting	
Narrative Biocriteria in WQS	none - General aquatic life statement found in WQS; informal process in place to translate RBP metrics to level of use support.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
	✓	permitted discharges
		monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Information discussed in water quality assessment reports along with recommendations for management, restoration and further monitoring.	

Reference Site/Condition Development

Number of reference sites	**5 - 10 total** *(on an annual basis)**	
Reference site determinations	✓	site-specific
	✓	paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Least impacted by known point discharges; least impacted by riparian zone land uses; habitat qualities comparable to test sites. For regional reference sites MADEP attempts to locate the least-disturbed sites by conducting extensive reconnaissance throughout the watershed and selecting sites that do not appear to have point or nonpoint sources of pollution upstream from them. Reference sites that represent the various sub-ecoregions that exist in Massachusetts are gradually being identified. This process is not yet complete, however.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: MADEP is working on identifying reference sites to represent various sub-ecoregions
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*MADEP does not have a fixed set of reference stations situated throughout the state. Rather, during the rotating basin schedule MADEP reconnaissances new reference sites depending upon where the sampling will take place. Therefore the number of reference sites may vary from year to year.

Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - watershed level*)
	✓	periphyton *(<100 samples/year; single season, multiple sites - some at watershed level)*
	✓	other: macrophytes *(<100 samples/year; single season, multiple sites - not at watershed level)*
Benthos		
sampling gear		multi-plate, rock baskets, collect by hand, single-pole kick-net (45 cm, rectangular, 500-600 micron mesh)
habitat selection		riffle/run (cobble)
subsample size		100 count
taxonomy		combination--genus, species
Fish		
sampling gear		backpack electrofisher, boat electrofisher, seine; 1/8", 3/16" and 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement, biomass - individual, anomalies
subsample		all species, 25 individuals of each
taxonomy		sub-species
Periphyton		
sampling gear		**natural substrate**: suction device, brushing/scraping device (razor, toothbrush, etc.), collect by hand; **artificial substrate**: microslides or other suitable substratum
habitat selection		richest habitat, riffle/run (cobble), multihabitat, artificial substrate
sample processing		chlorophyll *a*/ phaeophytin, biomass, taxonomic identification
taxonomy		genus level for soft-bodied algae when possible; diatoms are not cleared
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures; quality assurance plan; periodic meetings, training for biologists; limited taxonomic proficiency checks; specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds*		
transforming metrics into unitless scores		Follow 1989 EPA RBP guidelines (Figure 6.3-4)
defining impairment in a multimetric index		Follow 1989 EPA RBP guidelines: anything <83% of reference is impaired/impacted
Evaluation of performance characteristics		repeat sampling
	✓	precision *(duplicate sampling)*
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access 2000
Retrieval and analysis		MS Access 2000 - benthos database customized from EDAS

*Everything is determined relative to the reference sites; however some parts of this have been refined, including the similarity index thresholds, and MADEP hopes to use biocriteria data to further modify thresholds. MADEP has also evaluated a model community at order level as a substitute for similarity indices (see Novak & Bode, 1992).